

D-64068

OCO (Orbiting Carbon Observatory) Project OCO-2

Software Interface Specification for the SDOS Level 2 Fluorescence Product

Revision B
March 15, 2015

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Change Log

Revision	Date	Sections Changed	Author
Initial	6/16/14		C. Avis
Rev A	7/29/2014	1, 3, 4.1, 4.2, 5	B. Chafin
Rev B	3/15/2015	1, 5, App. 1	C. Avis

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1 Product Identification and Software Version

This document describes the specification of one of the data products generated by the OCO-2 Science Data Operations System (SDOS). This document applies to the following product and system version:

Product Name:	Level 2 Fluorescence Product
Short Name:	OCO2_L2_IMAPDOAS
SDOS System Version:	B6.0.00
GES DISC Version:	Version 6 and Version 6r
Product Description:	Geolocated, retrieved values of CO ₂ vertical column density and chlorophyll fluorescence generated by the Iterative Maximum A Posteriori Differential Optical Absorption Spectroscopy (IMAP-DOAS) algorithm

SDOS System B6.0.00 generates products either with predictive calibration parameters (Version 6) or with parameters derived via analysis of past instrument performance (Version 6r). Therefore, 6r is considered of higher quality. Analyses mixing the two sets should be undertaken with a degree of caution. The product specifications for 6 and 6r are identical and this document applies to both.

2 Background information

The OCO-2 SDOS converts telemetry downloaded from the Observatory into data products that provide comprehensive mission results as well as material for further research and investigation. The SDOS generates products from Level 0 through Level 2, some of which are available for distribution to both the scientific community and the general public. All products are available to users of the SDOS computing cluster.

2.1 NASA Data Levels

Table 1.1 provides the definitions of the data levels used in this document. These definitions are standard within the NASA community

Level	Description
Packet data	Telemetry data stream as received at the ground station, with science and engineering data embedded

Level 0	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed
Level 1A	NASA Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied)
Level 1B	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength)
Level 2	Geophysical parameters, generally derived from NASA Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling

2.2 Product Pedigree and Destination

This product is generated within the nominal SDOS pipeline by the IMAP-DOAS PGE using the following input data:

- ECMWF meteorological file
- Level 1B Science product

This product is expected to be an input to the following PGE's within the nominal SDOS pipeline:

- Full Physics
- Level 2 Diagnostic Product Generator PGE
- Sounding Selection PGE

2.3 Suggested Tools to Read Product

The following set of tools can be used to open and examine this HDF-5 product on Linux systems. Other tools may be available.

- h5dump
- hdfview

3 Reference Documents

1. OCO-2 SDOS Software Design Document (JPL D-71459)
2. OCO-2 SDOS Data Bible v6.0
3. OCO-2 Science Data Management and Archive Plan (JPL D-64039)
4. OCO-2 Algorithm Theoretical Basis Document IMAP-DOAS Preprocessor (JPL D-81519)

4 Product Description

4.1 Format and Size

This product is in HDF-5 format. For most nominal orbits, the product will use 13 Megabytes.

4.2 Naming Convention

oco2_*[ProductId]**[Mode]*_*[Orbit]**[ModeCounter]*_*[AcquisitionDate]*_*[ShortBuildId]*_*[ProductionDateTime]*.h5

Field	Description	Format	Selection
<i>ProductId</i>	A mnemonic indicating a file type.	String	L2IDP - Level 2 Fluorescence Product
<i>Mode</i>	The acquisition Mode associated with the data.	Two character string	GL - Sample Glint
			ND - Sample Nadir
			TG - Sample Target
			XS - Sample Transition
<i>Orbit</i>	The Orbit on which the associated data were acquired. If the Orbit number is less than 10,000, zeros are prepended to the number to ensure that the field is five digits long.	nnnnn	Actual Orbit number for data acquired during operations
<i>ModeCounter</i>	This field indicates how many times an acquisition Mode occurs in an Orbit. If a mode occurs only once, ModeCounter is set to "a".	Single character	a, b, c, ...

<i>AcquisitionDate</i>	The date (UTC) the data were acquired.	yymmdd	
<i>ShortBuildId</i>	The identification of the related software build	Bstuu	s = ID of major build cycle t = ID of scheduled build within a major build cycle uu = ID of incremental or patch build
<i>ProductionDateTime</i>	The date and time (UTC) that the file was produced.	yymmddhhmmss	

5 Specification Table

The HDF file structure consists of a large number of Data Elements with values. These Elements (a.k.a., ‘fields’) may be of various types (e.g., arrays, scalars) and are organized into Groups. Groups are utilized in various ways, such as to combine Elements/values generated by different PGE’s.

Description of column headers in the following tables:

Data Element	The name of the Data Element
Shape	See Appendix 1
Type	The data type of the values
Units	The SI units of the values, if any
Minimum value	The lowest possible value. In some cases, this is the lowest safe value (i.e., a ‘red’ limit)
Maximum value	The highest possible value. In some cases, this is the highest safe value (i.e., a ‘red’ limit)
Comments	Descriptive information about the Element
(no value = n/a)	

L2 IMAPDOAS Product HDF specification

Group	Metadata					
Group description	Granule-level Metadata					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
<u>Standard Metadata</u>	See OCO-2 Standard Metadata specification table below					
AcquisitionMode	Scalar	String				The instrument mode in which the data in the product were collected. Valid values are: 'Glint', 'Nadir', 'Target'
ActualFrames	Scalar	Int32				Actual number of frames reported in this product
ARPAncillaryDatasetDescriptor	Scalar	String				The name of the Ancillary Radiometric Product file used to calibrate this file
AscendingEquatorCrossingDate	Scalar	String				The date of the equator crossing of the spacecraft ground track in the ascending direction
AscendingEquatorCrossingLongitude	Scalar	Float32	Degrees	-180	180	The longitude of the equator crossing of the spacecraft ground track in the ascending direction
AscendingEquatorCrossingTime	Scalar	String				The time of the equator crossing of the spacecraft ground track in the ascending direction
AutomaticQualityFlag	Scalar	String				Not implemented - set to NULL
EphemerisType	Scalar	String				The source of the spacecraft ephemeris data that were utilized to generate this data file
EquatorCrossingDate	Scalar	String				The date of the equator crossing of the spacecraft ground track in the

						descending direction
EquatorCrossingLongitude	Scalar	Float32	Degrees	-180	180	5.1.1 The longitude of the equator crossing of the spacecraft ground track in the descending direction
EquatorCrossingTime	Scalar	String				The time of the equator crossing of the spacecraft ground track in the descending direction
ExpectedFrames	Scalar	Int32				Nominal number of frames in this product
FirstSoundingId	Scalar	Int64				The ID of the first sounding in this file
L2IDPAlgorithmDescriptor	Scalar	String				Identification of the algorithm and version used to generate this product
LastSoundingId	Scalar	Int64				The ID of the last sounding in this file
ModeCounter	Scalar	String				The Nth occurrence of this particular mode for this orbit, indicated by letter ('a', 'b', 'c', 'd', etc.)
OperationMode	Scalar	String				The two-letter abbreviation of the AcquisitionMode: GL, ND, TG, DS, LS, SS, BS, NP, GP, TP, DP, LP, SP, BP, XS, XP, MS, MP, SB
OrbitEccentricity	Scalar	Float32				The eccentricity of the spacecraft orbital path
OrbitInclination	Scalar	Float32	Degrees	0	180	The angle between the plane of the spacecraft orbital path and the Earth equatorial plane
OrbitParametersPointer	OrbitParamPtr_Array	String				The data files that provided the orbit parameters used to generate this product
OrbitPeriod	Scalar	Float32	Seconds			The time span between two consecutive descending node crossings
OrbitSemiMajorAxis	Scalar	Float32	Meters			The length of the semimajor axis of the spacecraft orbit
OrbitStartDate	Scalar	String				The date of the equator crossing of the spacecraft nadir track in the descending direction
OrbitStartLongitude	Scalar	Float32	Degrees	-180	180	The longitude of the equator crossing of the spacecraft ground track in the descending direction
OrbitStartTime	Scalar	String				The time of the equator crossing of the spacecraft ground track in the descending direction
ReportedSoundings	SoundingPosition_Array	Int8		0	1	Indicates the inclusion of each footprint in the data: 0 - not included, 1 - included
SpectralChannel	Spectrum_Array	String				A description of the spectral channels used for the measurements
Group	FrameGeometry					
Group description	Geometric information that applies to all measurements in frame					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
spacecraft_position	Frame_EuclidDim_Array	Float32	Meters			Interpolated spacecraft position at the frame time
spacecraft_velocity	Frame_EuclidDim_Array	Float32	Meters Second ^{-1}			Interpolated spacecraft velocity at the frame time
roll	Frame_Array	Float32	Degrees	-180	180	Interpolated spacecraft attitude at the frame time
pitch	Frame_Array	Float32	Degrees	-180	180	Interpolated spacecraft attitude at the frame time

yaw	Frame_Array	Float32	Degrees	-180	180	Interpolated spacecraft attitude at the frame time
spacecraft_lat	Frame_Array	Float32	Degrees	-90	90	Geodetic latitude of the spacecraft at the frame time
spacecraft_lon	Frame_Array	Float32	Degrees	-180	180	Longitude of the spacecraft at the frame time
spacecraft_alt	Frame_Array	Float32	Meters			Altitude of the spacecraft above the reference ellipsoid at the frame time
ground_track	Frame_Array	Float32	Degrees	0	360	Ground track orientation relative to local North
Group	SoundingGeometry					
Group description	Geometric information for each sounding					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
sounding_id	Frame_Sounding_Array	Int64				Unique identifier for each complete sounding
sounding_time_string	Frame_Sounding_Array	String				Representative measurement time of the sounding
sounding_time_tai93	Frame_Sounding_Array	Float64	Seconds			Representative measurement time of the sounding in seconds since Jan. 1, 1993
sounding_overlap	Frame_Sounding_Array	Float32	Percent	0	100	Area of intersection of all three band footprints relative to average area of all three band footprints
sounding_overlap_o2_weak_co2	Frame_Sounding_Array	Float32	Percent	0	100	Area of intersection of the footprints of ABO2 and WCO2 relative to the average area of the two footprint
sounding_overlap_weak_co2_strong_co2	Frame_Sounding_Array	Float32	Percent	0	100	Area of intersection of the footprints of WCO2 and SCO2 relative to the average area of the two footprints
sounding_overlap_strong_co2_o2	Frame_Sounding_Array	Float32	Percent	0	100	Area of intersection of the footprints of ABO2 and SCO2 relative to the average area of the two footprints
sounding_slant_path_diff_o2_weak_co2	Frame_Sounding_Array	Float32	Meters			The difference in slant path difference between ABO2 and WCO2 footprints
sounding_slant_path_diff_weak_co2_strong_co2	Frame_Sounding_Array	Float32	Meters			The difference in slant path difference between WCO2 and SCO2 footprints
sounding_slant_path_diff_strong_co2_o2	Frame_Sounding_Array	Float32	Meters			The difference in slant path difference between SCO2 and ABO2 footprints
sounding_center_offset_o2_weak_co2	Frame_Sounding_Array	Float32	Meters			Distance between the ABO2 band footprint center and the WCO2 band footprint center
sounding_center_offset_weak_co2_strong_co2	Frame_Sounding_Array	Float32	Meters			Distance between the WCO2 band footprint center and the SCO2 band footprint center
sounding_center_offset_strong_co2_o2	Frame_Sounding_Array	Float32	Meters			Distance between the SCO2 band footprint center and the ABO2 band footprint center
sounding_qual_flag	Frame_Sounding_Array	UInt64				Quality bits specific to each pixel
sounding_latitude_geoid	Frame_Sounding_Array	Float32	Degrees	-90	90	Geodetic latitude of the sounding based on standard geoid
sounding_longitude_geoid	Frame_Sounding_Array	Float32	Degrees	-180	180	Longitude of the IFOV based on standard geoid
sounding_latitude	Frame_Sounding_Array	Float32	Degrees	-90	90	Geodetic latitude of the IFOV based on SRTM Earth topography
sounding_longitude	Frame_Sounding_Array	Float32	Degrees	-180	180	Longitude of the sounding based on SRTM Earth topography

sounding_altitude	Frame_Sounding_Array	Float32	Meters			Altitude of the IFOV based on SRTM Earth topography
sounding_altitude_uncert	Frame_Sounding_Array	Float32	Meters			Standard deviation of the measure of altitude for the IFOV
sounding_slope	Frame_Sounding_Array	Float32	Degrees	0	180	Representative slope of surface at the location of the IFOV.
sounding_plane_fit_quality	Frame_Sounding_Array	Float32	Meters			The standard deviation of the points, to which the plane is fitted, with the expected values taken as the orthogonal projection of the points onto the plane.
sounding_aspect	Frame_Sounding_Array	Float32	Degrees	0	360	Orientation of the surface slope relative to the ground track.
sounding_surface_roughness	Frame_Sounding_Array	Float32	Meters			Standard deviation of the surface slope within the region of the IFOV
sounding_solar_distance	Frame_Sounding_Array	Float64	Meters			Distance between observed surface and the Sun
sounding_solar_azimuth	Frame_Sounding_Array	Float32	Degrees	0	360	Angle between the solar direction as defined from the sounding location to the sun, and the sounding location local north direction
sounding_solar_zenith	Frame_Sounding_Array	Float32	Degrees	0	180	Angle between the solar direction as defined from the sounding location to the sun, and the sounding location local zenith direction
sounding_azimuth	Frame_Sounding_Array	Float32	Degrees	0	360	Angle between the LOS as defined from the sounding location to the spacecraft, and the sounding location local north direction
sounding_zenith	Frame_Sounding_Array	Float32	Degrees	0	180	Angle between the LOS as defined from the sounding location to the spacecraft, and the sounding location local zenith direction
sounding_solar_relative_velocity	Frame_Sounding_Array	Float32	Meters Second ⁻¹			Velocity of the sun along the sounding location/Sun vector: negative indicates Sun moving toward sounding location
sounding_land_water_indicator	Frame_Sounding_Array	Int8		0	3	Surface type at the sounding location: 0 - Land, 1 - Water, 2 - unused, 3 - Mixed land water
sounding_land_fraction	Frame_Sounding_Array	Float32	Percent	0	100	Percentage of land surface type within the sounding
sounding_relative_velocity	Frame_Sounding_Array	Float32	Meters Second ⁻¹			Velocity of the spacecraft along the LOS: positive indicates spacecraft moving toward sounding location
sounding_polarization_angle	Frame_Sounding_Array	Float32	Degrees	0	360	The angle between the accepted polarization axis of the instrument and the instrument reference plane for polarization, defined as the plane formed by the LOS and the ray from the sounding location to the local zenith
Group	DOASCO2					
Group description	CO ₂ retrievals from the IMAP-DOAS algorithm					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
co2_column_weak_band_idp	Frame_Sounding_Array	Float32	Molecules Meters ⁻²			CO2 vertical column density (from WCO2 band)
co2_column_weak_band_apriori_idp	Frame_Sounding_Array	Float32	Molecules Meters ⁻²			<i>a priori</i> CO2 vertical column density from ECMWF forecast

co2_column_weak_band_uncert_idp	Frame_Sounding_Array	Float32	Molecules Meters ^{-2}			1-sigma error in the CO2 vertical column density (from WCO2 band)
co2_column_strong_band_idp	Frame_Sounding_Array	Float32	Molecules Meters ^{-2}			CO2 vertical column density (from SCO2 band)
co2_column_strong_band_apriori_idp	Frame_Sounding_Array	Float32	Molecules Meters ^{-2}			<i>a priori</i> CO2 vertical column density from ECMWF forecast
co2_column_strong_band_uncert_idp	Frame_Sounding_Array	Float32	Molecules Meters ^{-2}			1-sigma error in the CO2 vertical column density (from SCO2 band)
dry_air_column_apriori_idp	Frame_Sounding_Array	Float32	Molecules Meters ^{-2}			Integrated vertical column of dry airmass derived from meteorological data
co2_weak_band_processing_flag_idp	Frame_Sounding_Array	Int8		0	2	See Product Quality Flags below
co2_strong_band_processing_flag_idp	Frame_Sounding_Array	Int8		0	2	See Product Quality Flags below
Group	DOASCloudScreen					
Group description	CO ₂ retrievals from the IMAP-DOAS algorithm					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
cloud_flag_idp	Frame_Sounding_Array	Int8		-2	3	See Product Quality Flags below
co2_ratio_idp	Frame_Sounding_Array	Float32				Ratio of retrieved CO2 column (no scattering code) in WCO2 and SCO2 bands
h2o_ratio_idp	Frame_Sounding_Array	Float32				Ratio of retrieved H2O column (no scattering code) in WCO2 and SCO2 bands
h2o_ratio_uncert_idp	Frame_Sounding_Array	Float32				1-sigma error in the ratio of retrieved H2O column (no scattering code) in WCO2 and SCO2 bands
o2_ratio_idp	Frame_Sounding_Array	Float32				Ratio of retrieved and ECMWF O2 column
Group	DOASFluorescence					
Group description	CO ₂ retrievals from the IMAP-DOAS algorithm					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
fluorescence_qual_flag_idp	Frame_Sounding_Array	UInt8				See Product Quality Flags below
fluorescence_offset_relative_757nm_idp	Frame_Sounding_Array	Float32				Fraction of continuum level radiance explained by an additive offset term in the 757nm spectral window (unitless). In the absence of instrumental errors, this will be only caused by fluorescence. Rotational Raman scattering should be negligible over typical vegetated surface and moderate solar zenith angles (<65 degrees).
fluorescence_offset_relative_771nm_idp	Frame_Sounding_Array	Float32				Fraction of continuum level radiance explained by an additive offset term in the 771nm spectral window (unitless). In the absence of instrumental errors, this will be only caused by fluorescence. Rotational Raman scattering should be negligible over typical vegetated surface and moderate solar zenith angles (<65 degrees).
fluorescence_radiance_757nm_idp	Frame_Sounding_Array	Float32	Ph sec ^{-1} m ^{-2} sr ^{-1} 1} um ^{-1}			Radiance generated by fluorescence at 757nm

fluorescence_radiance_757nm_uncert_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Standard deviation of the radiance generated by fluorescence at 757nm
fluorescence_radiance_771nm_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Radiance generated by fluorescence at 771nm
fluorescence_radiance_771nm_uncert_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Standard deviation of the radiance generated by fluorescence at 771nm
iterations_fluorescence_757nm_idp	Frame_Sounding_Array	Int8				Number of iterations until convergence or max number of iterations achieved in 757 nm fluorescence fit window
iterations_fluorescence_771nm_idp	Frame_Sounding_Array	Int8				Number of iterations until convergence or max number of iterations achieved in 771 nm fluorescence fit window
residual_rms_fluorescence_757nm_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			RMS of fit residuals in 757 nm fluorescence fit window
residual_rms_fluorescence_771nm_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			RMS of fit residuals in 771 nm fluorescence fit window
residual_reduced_chi2_fluorescence_757nm_idp	Frame_Sounding_Array	Float32				Reduced chi squared of fit residuals in 757 nm fluorescence fit window
residual_reduced_chi2_fluorescence_771nm_idp	Frame_Sounding_Array	Float32				Reduced chi squared of fit residuals in 771 nm fluorescence fit window
maximum_signal_in_window_757nm_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Maximum observed radiance value within 757 nm fluorescence fit window
maximum_signal_in_window_771nm_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Maximum observed radiance value within 771 nm fluorescence fit window
continuum_level_radiance_757nm_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Fitted continuum level radiance value within 757 nm fluorescence fit window
continuum_level_radiance_771nm_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Fitted continuum level radiance value within 771 nm fluorescence fit window
local_daily_avg_cos_sza_idp	Frame_Sounding_Array	Float32				Average cosine of solar zenith angle within +/-12 hours of the data acquisition time for the sounding
igbp_index_idp	Frame_Sounding_Array	Int8				International Geosphere-Biosphere Programme (IGBP) One-Minute Land Ecosystem Classification Product (index) at the OCO-2 footprint
fluorescence_offset_relative_757nm_corr_idp	Frame_Sounding_Array	Float32				Bias-corrected relative fluorescence radiance at 757nm
fluorescence_radiance_757nm_corr_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Bias-corrected absolute fluorescence radiance at 757nm
fluorescence_offset_relative_771nm_corr_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Bias-corrected relative fluorescence radiance at 771nm
fluorescence_radiance_771nm_corr_idp	Frame_Sounding_Array	Float32	$\text{Ph sec}^{\{-1\}} \text{m}^{\{-2\}} \text{sr}^{\{-1\}} \text{um}^{\{-1\}}$			Bias-corrected absolute fluorescence radiance at 771nm

Group	L1bScSpectralParameters					
Group description	Spectral parameters derived in the L1b process applying to every sounding in source L1bSc product					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
snr_o2_l1b	Frame_Sounding_Array	Float32				The mean signal-to-noise ratio of the good samples in the band falling between the 98th and 99th percentile for signal level
snr_weak_co2_l1b	Frame_Sounding_Array	Float32				The mean signal-to-noise ratio of the good samples in the band falling between the 98th and 99th percentile for signal level
snr_strong_co2_l1b	Frame_Sounding_Array	Float32				The mean signal-to-noise ratio of the good samples in the band falling between the 98th and 99th percentile for signal level
spike_eof_bad_colors_o2	Frame_Sounding_Array	Int16				Number of bad colors in individual spectra and footprint
spike_eof_bad_colors_weak_co2	Frame_Sounding_Array	Int16				Number of bad colors in individual spectra and footprint
spike_eof_bad_colors_strong_co2	Frame_Sounding_Array	Int16				Number of bad colors in individual spectra and footprint
max_declocking_factor_o2	Frame_Sounding_Array	Float32				Maximum clocking correction factor of the footprint
max_declocking_factor_weak_co2	Frame_Sounding_Array	Float32				Maximum clocking correction factor of the footprint
max_declocking_factor_strong_co2	Frame_Sounding_Array	Float32				Maximum clocking correction factor of the footprint

Product Quality Flags

co2_weak_band_processing_flag_idp co2_strong_band_processing_flag_idp		cloud_flag		fluorescence_qual_flag	
Value	Meaning	Value	Meaning	Value	Meaning
0	Processing succeeded	-2	Measurements unusable	0	Good
1	Processing failed	-1	Did not converge	1	Bad
2	Processing skipped	0	Definitely cloudy		
		1	Probably cloudy		
		2	Probably clear		
		3	Very clear		

Bit	sounding_qual_flag
0	0 = The PGE successfully calculated the sounding position.
1	0 = Reported sounding time valid
2	0 = Ephemeris data associated with sounding invalid
3	0 = Attitude data associated with sounding invalid
4	1= Aperture blocked by Cal Door while in Science mode
5-15	Spare
16	0 = The PGE successfully calculated the ABO2 sample radiances for the current sounding.
17	0 = The PGE successfully calculated the WCO2 sample radiances for the current sounding.
18	0 = The PGE successfully calculated the SCO2 sample radiances for the current sounding.
19	0 = Frame-level engineering data valid
20	0 = ABO2 engineering data valid
21	0 = WCO2 engineering data valid
22	0 = SCO2 engineering data valid
23	0 = ABO2 summed offset and multiplier valid
24	0 = WCO2 summed offset and multiplier valid
25	0 = SCO2 summed offset and multiplier valid
26	0 = ABO2 footprint position valid
27	0 = WCO2 footprint position valid
28	0 = SCO2 footprint position valid
29	0 = Radiance for all colors is less than or equal to measureable_signal_max_observed for ABO2
30	0 = Radiance for all colors is less than or equal to measureable_signal_max_observed for WCO2
31	0 = Radiance for all colors is less than or equal to measureable_signal_max_observed for SCO2
32-47	Spare
48-63	Reserved for higher-level processing

OCO-2 Standard Metadata

Group	Metadata					
Group description	This table describes the metadata contained in all OCO-2 HDF products. These metadata fields appear in the Metadata group in each of these products. Each product may also contain product-specific fields in that group.					
Data Element	Shape	Type	Units	Minimum value	Maximum value	Comments
AncillaryDataDescriptors	AncFile_Array	String				The file names of the ancillary data files that were used to generate this product (ancillary data sets include all input files except for the primary input files)
BuildId	Scalar	String				The ID of build in which included the software that created this product
CollectionLabel	Scalar	String				Label of the data collection containing this product
DataFormatType	Scalar	String				'NCSA HDF' - A character string that describes the internal format of the data product.
GapStartTime	Gap_Array	String				The timestamp after which a nonexistent, unnecessary, spurious, questionable, or erroneous data segment begins. Set to 1993-01-01T00:00:00.000Z if no bad segment exists.
GapStopTime	Gap_Array	String				The timestamp before which a nonexistent, unnecessary, spurious, questionable, or erroneous data segment ends. Set to 1993-01-01T00:00:00.000Z if no bad segment exists.
GranulePointer	Scalar	String				The filename of this product
HDFVersionId	Scalar	String				'5.x' - A character string that identifies the version of the HDF (Hierarchical Data Format) software that was used to generate this data file
InputPointer	InputPtr_Array	String				A pointer to one or more data granules that provide the major input that was used to generate this product.
InstrumentShortName	Scalar	String				'OCO-2' - The name of the instrument that collected the telemetry data
LongName	Scalar	String				A complete descriptive name for the data type of this product
PlatformLongName	Scalar	String				'Orbiting Carbon Observatory 2'
PlatformShortName	Scalar	String				'OCO-2'
PlatformType	Scalar	String				'spacecraft' - The type of platform associated with the instrument which acquires the accompanying data
ProcessingLevel	Scalar	String				Indicates data level (Level 0, Level 1A, Level 1B, Level 2) in this product
ProducerAgency	Scalar	String				'NASA' - Identification of the agency that provides the project funding
ProducerInstitution	Scalar	String				'JPL' - Identification of the institution that provides project management.
ProductionDateTime	Scalar	String				The date and time at which the product was created (yyyy-mm-ddThh:mm:ss.mmmZ)
ProductionLocation	Scalar	String				Facility in which this file was produced, typically: 'Operations Pipeline', 'Operations Pipeline 2', 'Science Computing Facility', 'Test Pipeline', 'Test Pipeline 2'
ProductionLocationCode	Scalar	String				One-letter code indicating the ProductionLocation, typically: ' ' - Operations Pipelines (1) or 2, 's' - Science Computing Facility, 't' - Test Pipelines (1) or 2

ProjectId	Scalar	String				'OCO-2' - The project identification string
QAGranulePointer	Scalar	String				A pointer to the quality assessment product that was generated with this product
RangeBeginningDate	Scalar	String				The date on which the earliest data contained in the product were acquired (yyyy-mm-dd)
RangeBeginningTime	Scalar	String				The time at which the earliest data contained in the product were acquired (hh:mm:ss.mmmZ)
RangeEndingDate	Scalar	String				The date on which the latest data contained in the product were acquired (yyyy-mm-dd)
RangeEndingTime	Scalar	String				The time at which the latest data contained in the product were acquired (hh:mm:ss.mmmZ)
ShortName	Scalar	String				The short name identifying the data type of this product
SISName	Scalar	String				The name of the document describing the contents of the product
SISVersion	Scalar	String				The version of the document describing the contents of the product
SizeMBECSDDataGranule	Scalar	Float32	Megabytes			The size of this data granule in Megabytes
StartOrbitNumber	Scalar	Int32		1	99999	The first orbit on which data contained in the product were acquired
StartPathNumber	Scalar	Int32		1	233	The first WRS path on which data contained in the product was collected
StopOrbitNumber	Scalar	Int32		1	99999	The last orbit on which data contained in the product were acquired
StopPathNumber	Scalar	Int32		1	233	The last WRS path on which data contained in the product was collected

6 Appendix 1: Shape Descriptions

The shape name of a data element is a descriptive label that describes the rank and dimensions of that element.

Rules for creating shapes:

1. Shape names do not include any context information, such as what mode the instrument is in when it takes data with that shape. Any context information needed to distinguish between similarly named dimensions is appended as a label, just before the "_Array" suffix.
2. Any "temporal" dimension, e.g. Frame, is always outermost.
3. If Frame and Sounding are both present, they occur in direct sequence, i.e. Frame_Sounding_.
4. Shapes that include Frame, Sounding, and Spectrum cannot have any additional dimensions.
5. Spectrum precedes all other physical instrument dimensions, except when this rule contradicts any of the above rules.
6. If Spectrum and Sounding are present in the absence of Frame, they occur in direct sequence, i.e., Spectrum_Sounding.
7. Color comes after SinglePixel.
8. SinglePixel comes after Slice.

Shape	Rank	Max dimension sizes (Units)	Dimensions
AncFile_Array	1	20 (Number of ancillary input files)	AncFile
Frame_Array	1	10512 (Frames)	Frame
Frame_EuclidDim_Array	2	10512 (Frames) x 3 (Attitude dimensions)	Frame, EuclidDim
Frame_Sounding_Array	2	10512 (Frames) x 8 (Soundings)	Frame, Sounding
Gap_Array	1	10 (Number of gaps)	Gap
InputPtr_Array	1	20 (Number of primary input files)	InputFile
OrbitParamPtr_Array	1	16 (Attitude and ephemeris files)	OrbitFile
SoundingPosition_Array	1	8 (Maximum number of footprints)	SoundingPosition
Spectrum_Array	1	3 (Spectrometers)	Spectrum

7 Appendix 2: Acronyms

APID	Application Process Identifier
ASCII	American Standard Code for Information Interchange
ASD	Algorithm Specification Document
ATBD	Algorithm Theoretical Basis Document
CO ₂	Carbon Dioxide
DAAC	Distributed Active Archive Center
DOORS	Dynamic Object Oriented Requirements
ECHO	Earth observing system Clearing HOuse - The NASA-developed spatial and temporal metadata registry
ECMWF	European Center for Medium-range Weather Forecast
EDOS	EOS Data and Operations System
EOS	Earth Observing System
GES DISC	Goddard Earth Sciences Data and Information Services Center
HDF	Hierarchical Data Format
HECC	High-end Computing Capability
ICD	Interface Control Document
IMAP-DOAS	<i>Iterative Maximum A Posteriori</i> Differential Optical Absorption Spectroscopy
IOC	In-Orbit Checkout
ITAR	International Traffic in Arms Regulations
MOS	Mission Operations System
MOU	Memorandum of Understanding
NAS	NASA Advanced Supercomputing
NASA	National Aeronautics and Space Administration
O ₂	Oxygen
OCO	Orbiting Carbon Observatory
PGE	Product Generation Executive
SCF	Science Computing Facility
SDOS	Science Data Operations System
SIS	Software Interface Specification
SP4A	Simple, Scalable Script-based Science Processor Archive

TBD	To Be Determined
TCCON	Total Carbon Column Observing Network
UTC	Coordinated Universal Time
X _{CO2}	Column-averaged dry air mole fraction of atmospheric CO ₂